(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 302 667 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.04.2003 Bulletin 2003/16

(51) Int Cl.[7]: **F04D 19/04**

(21) Application number: **02257066.7**

(22) Date of filing: **11.10.2002**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **15.10.2001 GB 0124731**

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(54) Vacuum pumps

(57) A compound vacuum pump comprising at least one turbo-molecular stage and downstream therefrom a multi-channel molecular drag stage, a first inlet through which fluid can pass through the turbo-molecular stage and the molecular drag stage towards a pump outlet, a second inlet through which fluid can enter the pump at a location between the turbo-molecular and the molecular drag stages to pass only through the molecular drag stage towards the pump outlet, in which one or more channels of the molecular drag stage are adapted to communicate directly with the second inlet whilst the remaining channel or channels communicate with the turbo-molecular stage.

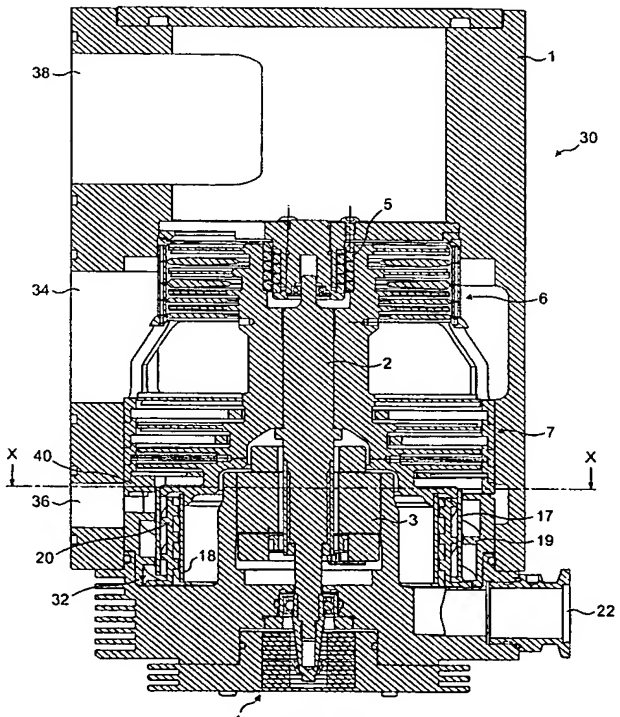

FIG. 2

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Description

[0001] This invention relates to vacuum pumps and in particular to compound vacuum pumps which employ at least one turbo-molecular stage and one molecular drag stage.

[0002] There is described in European patent publication number 0 919 726 a vacuum pump comprising first and second turbo-molecular stages and a molecular drag (Holweck) stage. This known pump has a first inlet through which fluid being pumped passes through all the pump stages and a second inlet through which fluid enters the pump between the two turbo-molecular stages and passes only through one turbo-molecular stage and the Holweck stage. The turbo-molecular stage upstream of the second inlet is sized differently from the turbo-molecular stage downstream of the second inlet so that the vacuum pump suits the pressure requirements or pumping capacities of the chambers/systems being evacuated and attached to the first and second inlets respectively.

[0003] This known "split flow" turbo-molecular pump facilitates the differential pumping of, for example, two chambers of a scientific instrument. For example, in well known types of mass spectrometer that part of the apparatus known as the detector commonly has to be operated at, for example, 10^{-6} mbar whereas that part known as the analyser has to be operated at a different level of vacuum for example 10^{-3} mbar. The chamber requiring the lower pressure (higher vacuum) is attached to the first inlet so that the fluid being evacuated is subject to all the stages of the pump whilst the chamber requiring the higher pressure (lower vacuum) is attached to the second inlet so that the fluid being evacuated is subject only to the pump stages downstream of the second inlet.

[0004] With liquid phase mass spectrometer (MS) systems there is increasingly a demand for higher gas loads to be consumed by the vacuum system. The highest gas load handling capacity is required at the comparatively "high" pressure end of the pump.

[0005] As the gas load diminishes in the subsequent chambers so to the system pressure decreases until eventually it reaches a level acceptable for analysis.

[0006] It is an aim of the present invention to provide an improved compound vacuum pump including at least one turbo-molecular stage and downstream therefrom a multi-channel molecular drag stage in which one or more channels of the molecular drag stage are devoted to pumping a high pressure fluid inlet whilst the remainder of the channels are devoted to "back" the turbo-molecular stage.

[0007] According to the present invention, a compound vacuum pump comprises at least one turbo-molecular stage and downstream therefrom a multi-channel molecular drag stage, a first inlet through which fluid can pass through the turbo-molecular stage and the molecular drag stage towards a pump outlet, a second inlet through which fluid can enter the pump at a location between the turbo-molecular and the molecular drag stages to pass only through the molecular drag stage towards the pump outlet, in which one or more channels of the molecular drag stage are adapted to communicate directly with the second inlet whilst the remaining channel or channels communicate with the turbo-molecular stage.

[0008] Preferably, the multi-channel molecular drag stage is a Holweck stage with a plurality of channels arranged as a plurality of helixes.

[0009] In one embodiment, a baffle directs one or more of the helical channels of the Holweck stage towards the second inlet.

[0010] An embodiment of the invention will now be described, by way of example, reference being made to the Figures of the accompanying diagrammatic drawings in which:

Figure 1 is a vertical cross-section through a known compound vacuum pump employing two turbo-molecular stages, a Holweck stage, a low pressure inlet and a high pressure inlet;

Figure 2 is a vertical cross-section through a compound vacuum pump according to the present invention;

Figure 3 is a cross section on the line X-X of Figure 2;

Figure 4 is an enlarged detail of the compound vacuum pump of Figures 2 and 3 at a high pressure inlet interstage between a turbo-molecular stage and a Holweck stage;

Figure 5 is a detail in perspective of the Holweck stage and a baffle member forming part of the compound vacuum pump of Figure 2; and

Figure 6 is a schematic illustration of an embodiment of the invention in which a single channel of the Holweck stage is directed to communicate directly with a high pressure fluid inlet whilst the remaining four channels communicate with a turbo-molecular stage.

[0011] Referring first to Figure 1 there is shown a known compound vacuum pump having a multi-component body 1 within which is mounted a shaft 2. Rotation of the shaft 2 is effected by a motor 3 positioned about the shaft 2. The shaft 2 is mounted in lower and upper bearings 4, 5 respectively.

[0012] The pump includes two sets of turbo-molecular stages 6, 7. The first set of turbo-molecular stages 6 comprises four rotor and stator blade pairs of known angled construction, a rotor blade stage is indicated at 8 and a stator blade stage is indicated at 9.

[0013] The second set of turbo-molecular stages 7 comprises a further six rotor and stator blade pairs of angled construction, a rotor blade stage is indicated at 12 and a stator blade stage is indicated at 13 in the drawing.

[0014] The pump is provided with a low pressure inlet 10 and a higher pressure inlet 16.

[0015] Downstream of the turbo-molecular stage 7 are a number of Holweck stages. These Holweck stages comprise two rotating cylinders 17, 18 and corresponding annular stators 19, 20 having helical channels formed therein all in a manner known per se. Downstream of the Holweck stages is a pump outlet 22.

[0016] In this known pump, the inlet 10 is connected to a chamber/system requiring a relatively high vacuum (low pressure) and the fluid pumped through the inlet 10 passes through both the turbo stages 6, 7 and also the Holweck stages and exits the pump via the outlet 22. The inlet 16 is connected to a chamber/system requiring less vacuum (higher pressure) and the fluid pumped through the inlet 16 passes only through the turbo-molecular stages 7 and the Holweck stages and exits the pump via the outlet 22.

[0017] Referring now to Figures 2 to 4 where like reference numerals denote like parts, a compound vacuum pump 30 comprises a body 1 within which is mounted a vertical shaft 2 supported by lower and upper bearings 4, 5. Rotation of the shaft 2 is effected by a motor 3.

[0018] The pump 30 has two sets of turbo-molecular stages 6, 7 and a Holweck stage 32.

[0019] The pump 30 has three inlets and an outlet 22. The first inlet 34 (mid gas pressure) is located interstage the two turbo-molecular stages 6, 7; the second inlet 36 (high gas pressure) is located interstage the turbo-molecular stage 7 and the Holweck stage 32; and the third inlet 38 (low gas pressure) is located upstream of all three stages.

[0020] The Holweck stage 32 includes two rotating cylinders 17, 18 and corresponding annular stators 19, 20 and helical channels formed thereon all in a manner known per se.

[0021] According to the invention, and as shown in Figure 6, one or more channels of the Holweck stage 32 is adapted to communicate directly with the high pressure inlet 36 whilst the remaining channel or channels communicate and serve to back turbo-molecular stage 7.

[0022] Referring also to Figure 5, the Holweck stage 32 is provided with a baffle member 40 having a radially inwardly directed flange 42 which allows only one channel (as shown) of the Holweck stage to communicate with the high pressure gas inlet 36 and prevents back streaming of the high pressure gas in to the turbo blades of the turbo-molecular stage 7.

[0023] The remaining channels of the Holweck stage are used to "back" the turbo blade stages of the turbo-molecular stage 7.

[0024] It will be apparent that the flange 42 could be extended so that more than one channel could be directed at the high pressure gas inlet 36.

[0025] A particular advantage of the embodiment described above is that the use of varying numbers of Holweck molecular drag stage channels for the purpose of either pumping the high pressure inlet or "back" the turbo blades stages 7 is matched to individual scientific instrument applications.

Claims

1. A compound vacuum pump comprising at least one turbo-molecular stage and downstream therefrom a multi-channel molecular drag stage, a first inlet through which fluid can pass through the turbo-molecular stage and the molecular drag stage towards a pump outlet, a second inlet through which fluid can enter the pump at a location between the turbo-molecular and the molecular drag stages to pass only through the molecular drag stage towards the pump outlet, in which one or more channels of the molecular drag stage are adapted to communicate directly with the second inlet whilst the remaining channel or channels communicate with the turbo-molecular stage.

2. A compound vacuum pump as claimed in Claim 1 in which the multi-channel molecular drag stage is a Holweck stage with a plurality of channels arranged as a plurality of helixes.

3. A compound vacuum pump as claimed in Claim 2 in which a baffle directs one or more of the helical channels of the Holweck stage towards the second inlet.

4. A compound vacuum pump as claimed in any one of Claims 1 to 3 in which at least two turbo-molecular stages are provided upstream of the Holweck stage.

5. A compound vacuum pump as claimed in Claim 4 in which the pump has at least one additional inlet through which fluid will pass through both the turbo-molecular stages and the molecular drag stage towards the outlet.

6. A compound vacuum pump as claimed in Claim 3, Claim 4 or Claim 5 in which the baffle includes a flange for inhibiting the back streaming of fluid from the Holweck stage towards the turbo-molecular stage.

7. A compound vacuum pump constructed, arranged and adapted to operate substantially as hereinbefore described with reference to Figures 2 to 5 of the accompanying drawings.

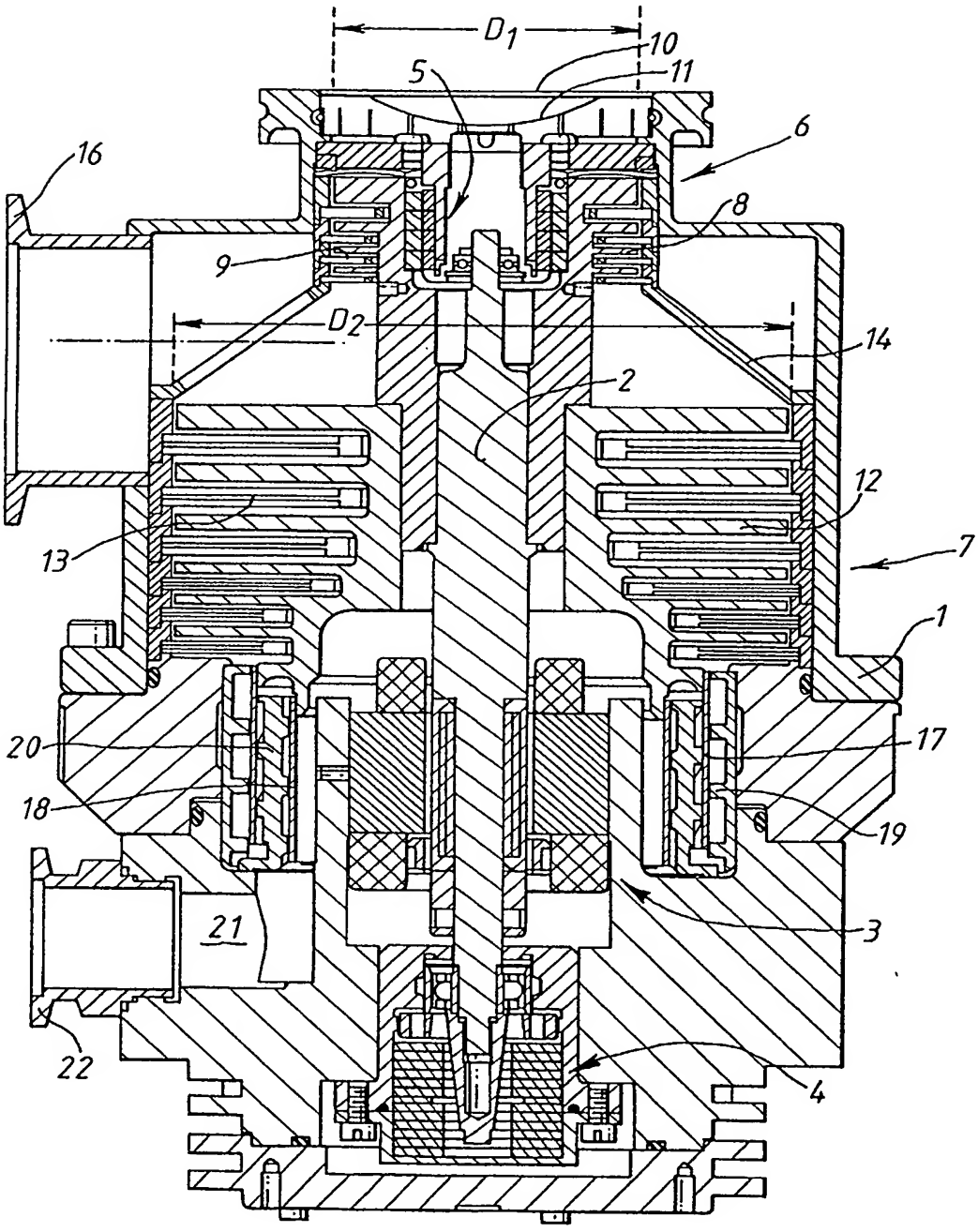

FIG. 1

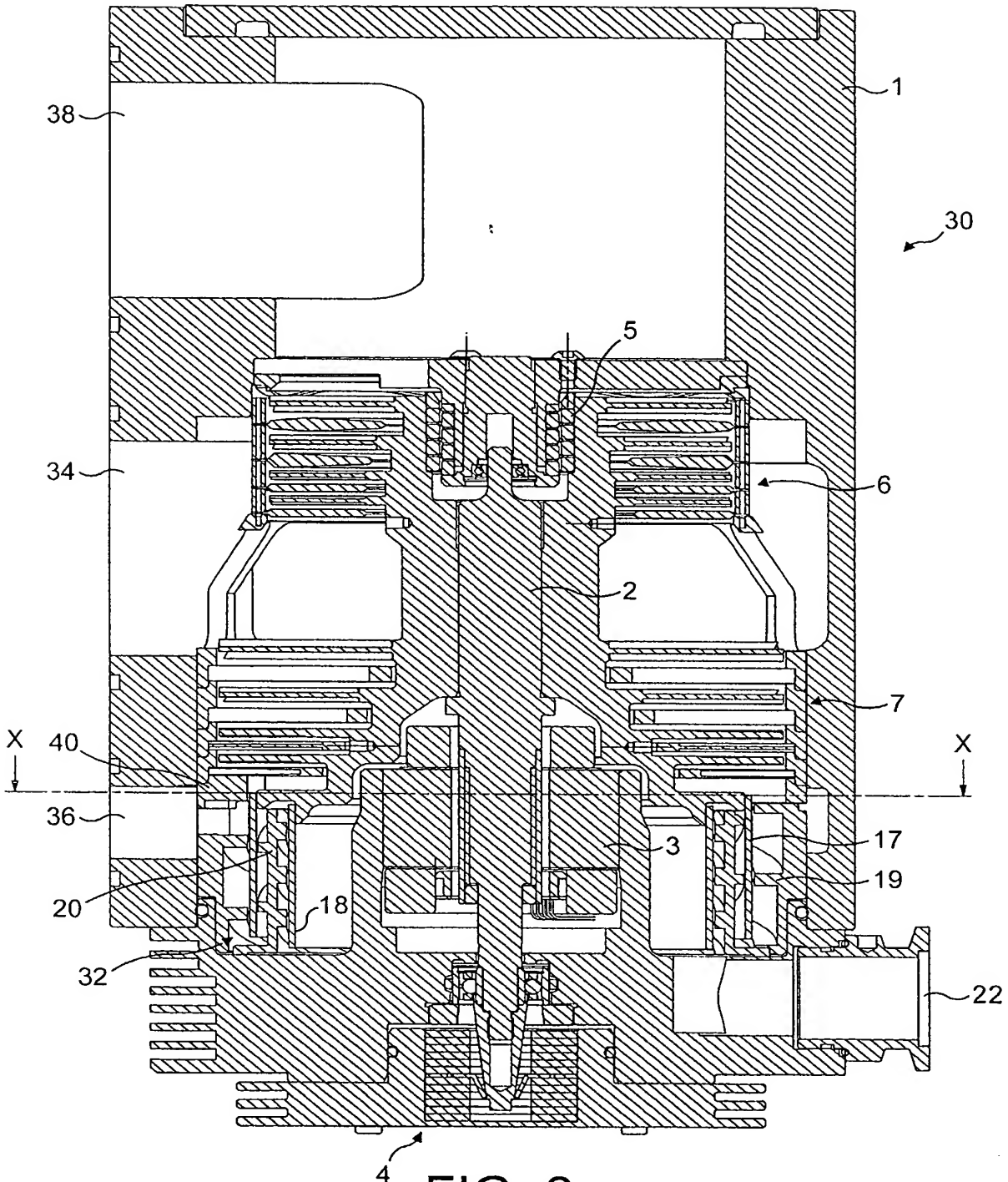

FIG. 2

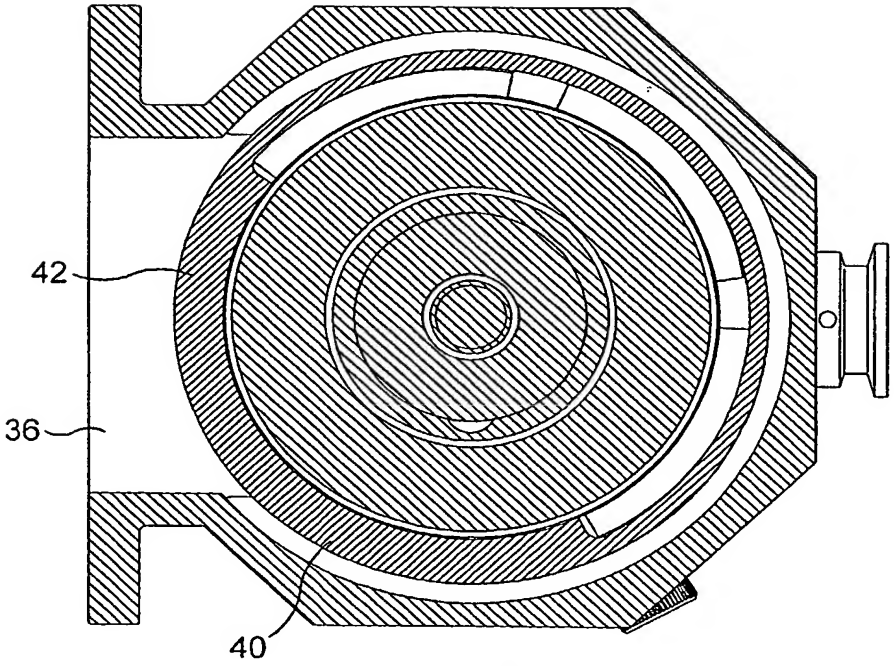

FIG. 3

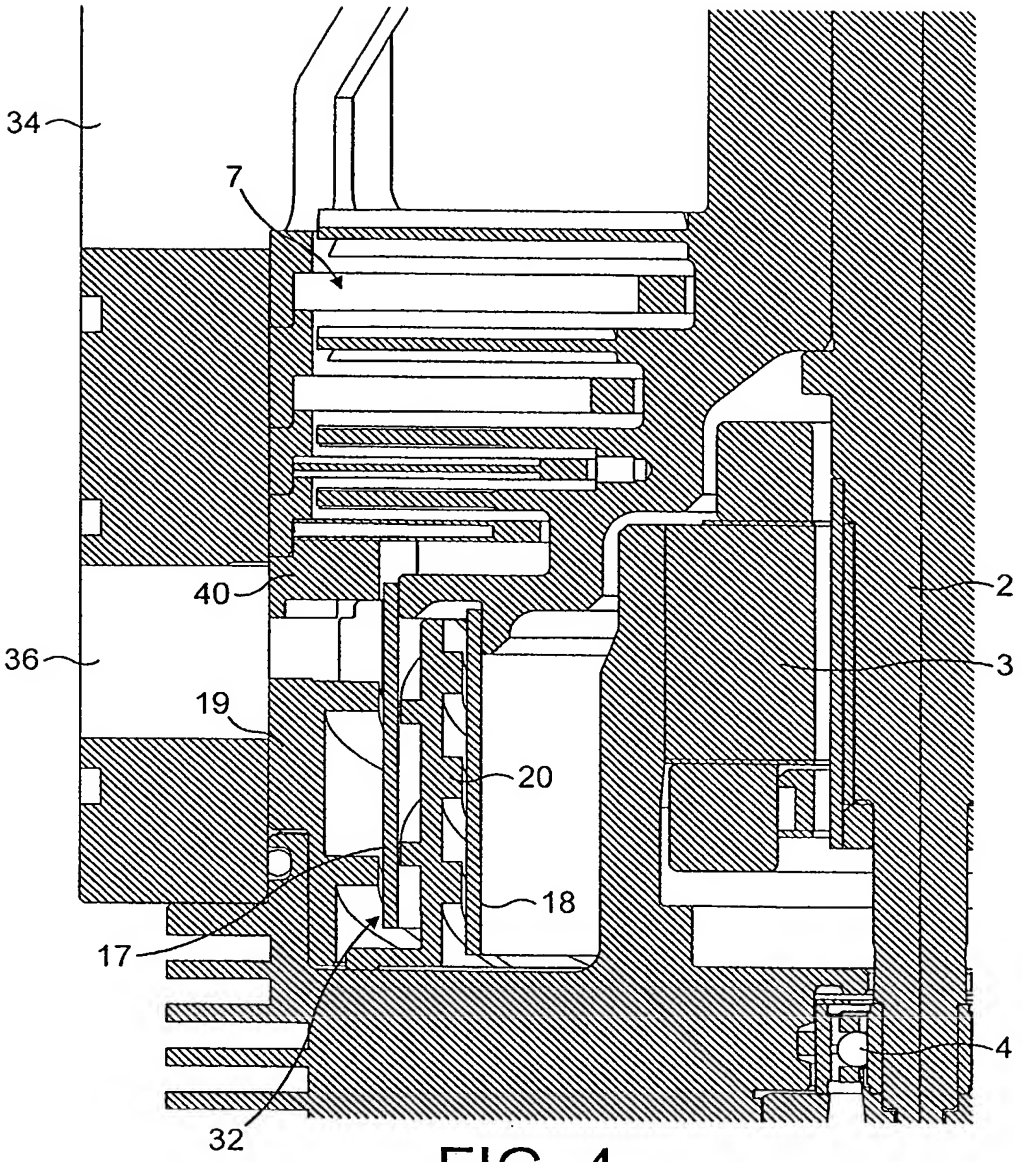

FIG. 4

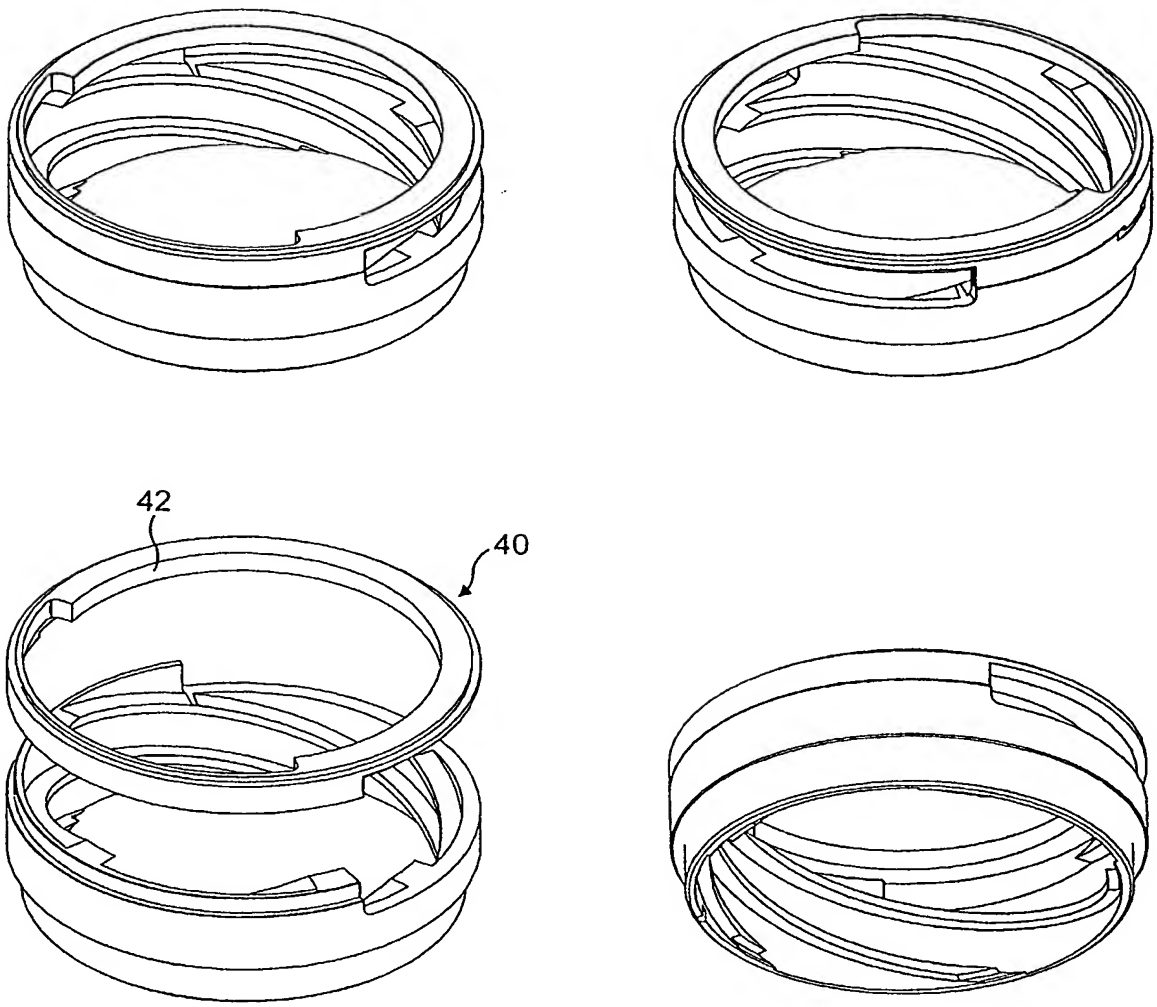

FIG. 5

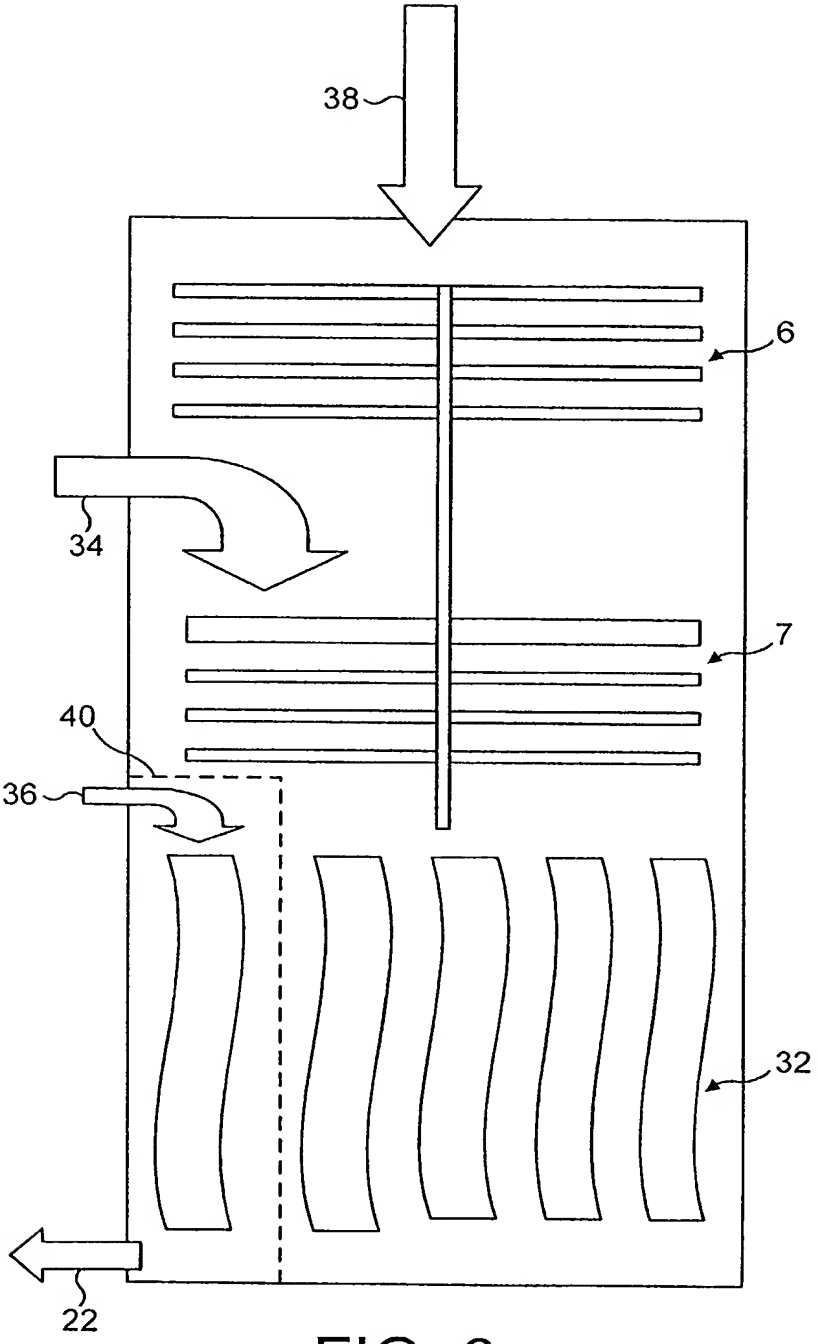

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 02 25 7066

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	GB 2 360 066 A (BOC GROUP PLC) 12 September 2001 (2001-09-12) * the whole document * ---	1-7	
A	US 6 193 461 B1 (HABLANIAN MARSBED) 27 February 2001 (2001-02-27) * abstract * * column 1, line 38-46 * * column 2, line 39-49 * ---	1-7	
A	US 5 733 104 A (GANSCHOW OTTO ET AL) 31 March 1998 (1998-03-31) * column 6, line 9, paragraph 43; figures 6,8 * -----	1-7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	6 December 2002	Olona Laglera, C

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 02 25 7066

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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